# PROCESS-BASED PRACTICALS
# IN
# PHYSICAL SCIENCE
# AT THE SECONDARY LEVEL

MATERIALS DEVELOPED IN THE
WORKSHOP HELD AT R. C. E.,
BHUBANESWAR, FROM 23. 7. 93 TO 29. 7. 93

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BHUBANESWAR-751007
1993-94

# FOREWORD

The Workshop on "Development of Process-based practicals in Physical science at the Secondary level" was held at Regional College of Education, Bhubaneswar from 23.7.93 to 29.7.93 and is the Second phase of the programme. The first phase programme was held during February - March, 1993 at Shillong where participants from Assam, Meghalaya and Sikkim took part. The second phase programme was planned for the States of West Bengal and Orissa. However, there was no response from West Bengal and 8 participants from Orissa joined the programme.

Although all Educational Planners and classroom teachers are convinced that performing practical is the most important instructional tool for developing meaningful learning in science, performing practicals still remains the most neglected area in the teaching science at the secondary level. It is hoped that the outcome of this programme will provide the necessary scafolding to bridge the gap between "Conviction" and "Practice". The whole thrust of this programme was to design process-based practicals with emphasis on child centered approach.

The efforts of the Programme Director and the Internal Resource faculty are very much appreciated. The objective of the workshop will be achieved if the classroom teachers follow the guidelines incorporated in this Report.

Narain Khattar
( Prof.N.Khattar )
PRINCIPAL

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# RATIONALE

Dr.J.K.Mohapatra

The National Policy of Education, 1986 and its modified version of 1992 alongwith the accompanying volume of Programme Of Action, 1992, emphasize two basic points with regards to Science Education at the Secondary level. They are, (a) the science education should be planned in such a way as to be in tune with the readiness of the child and (b) the teaching should be child-centred instead of being teacher-centred.

An imperative categorization of the term "readiness of the child" is operationally useful for designing the curriculum and for formating and drafting the associated text books. In defining readiness of the child one has several option. One may use the Piagetian approach and use his stage dependent model, one may use the Brunerian approach through his heuristic model, one may use the Neo-Piagetian model of Pascuall-Leone with his M - space formalism or even one may make efforts to use the zone of proximal development model of Vygotsky. Or,perhaps the latest approach could be the use of pupils alternative conceptions.

In so far as child-centred teaching is concerned i.e. a teaching model where the teacher is no longer the director but is an equal actor on the stage, the teacher is not to provide prescriptive instructions but only facilitate the learning. We distinguish between two approaches - Child - centred - for - the - child ( CCFC ) and Child-centred-by- the- child ( CCBC ). The CCFC is again more concerned with the curriculum and text-book where as CCBC deals with the activities to be performed by the child, the participation by the child in discussions, the role to be played by the child in demonstrations etc. In brief it deals with something to be done by the child. It is in this area that we are concerned in this workshop because "learning by doing" leaves more permanent imprint in the epitaxy of child's memory.

However, "learning by doing" is a highly neglected area in science education at the secondary level. This is so, because, at the secondary level, -

a) Performing practical is not a part of the evaluative curriculum.

b) In those systems where some practicals are listed, performing practical is regarded as a morbid, monotonous activity because in almost all the cases the instruction is prescriptive, the apparatus and hence the experiment is well defined, even the calculations and analysis are pre-designed. This is so because the practicals are either to verify some known law, or, to determine some known quantity, or to get acquainted with some instrument.

c) Most of the practicals are designed to only supplement the theory i.e., they are content-based practicals.

d) Because of (c), above, most of these practicals require sophisticated equipment and hence finance, which is in short supply.

e) Doing practicals is never regarded as a challenging or stimulating activity either for the teacher or for the pupil.

Over and above this, for more than 70% of the school going children, completion of the secondary level studies happens to be the terminal stage of their education. Coupled with this, if education is regarded as a tool to define a way of life for a citizen, then one should be very pragmatic in prescribing practicals for the secondary level. This workshop is a functional step in that direction.

Before detailing out the practicals, one needs to search for answer to two questions.

a) If 70% of the pupils leave education after the secondary stage, then WHY should they perform practicals ?

b) If at all they are to perform practicals, WHAT should be their form and structure ?

The possible answer to the first question is that in order to make him/her a scientifically conscious citizen in the future society, the pupils need to do practicals, because, then only they will have a real feeling of what science means for the common man. The common citizen is least interested in the scientific theories. But he will definitely like to find out, which detergent powder is good for use in his family, how much water has been admixtured to the milk he purchases, how many strands of thin copper wire, present inside the flexible wire, he can use as a substitute for the fuse in the cut-out present inside the main switch.

Since he would like to find out answers to these and many other questions which he will be facing in his daily life, he should, during the course of the secondary education, learn how to find out, in other words he should know the 'processes of science.'

Once we agree on this point, the answer to the second question becomes simple. The answer is - the practicals, should be 'process-based' and not 'content-based', keeping in view the basis that "Processes" are those which are still remembered much after the facts have been forgotten.

The objectives of the process-based practicals, to be designed in this workshop, will be the following.

a) The pupil will learn & put into practice the processes of science.

b) He/she may learn some content while performing the experiment but learning content will not be aimed at.

c) The experiment should be designed in such a way that they can be performed without the use of any sophisticated equipment.

d) The instruction will be suggestive but not prescriptive.

e) There will be scope for variations so that it will stimulate and challenge the pupil.

f) More scope should be given to the pupil, to think, plan and design the experiment.

g) The practicals should be more child-centered than teacher-centered.

We in this workshop plan to develop certain process-based practicals so that the teacher can learn them and subsequently transmit the knowledge to the pupils by helping them to learn how to know.

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# PROCESSES IN PRACTICALS

In the early sessions of the workshop, a total of 30 processes in practicals were identified through group discussions. These processes were classified into three broad groups, namely,

PR: Processes in Pre-experiment stage
DU: Processes in During - experiment stage
PO: Processes in Post-experiment stage.

The specific processes in each stage are listed below:

## Pre-experiment stage:

PR.1: Identifying a problem
PR.2: Identification, selection and control of variables.
PR.3: Making a hypothesis
PR.4: Designing of an experiment
PR.5: Identification of precautions
PR.6: Development of manipulative skill
PR.7: Development of fabrication skill

## During - experiment stage:

DU.1: Conducting an experiment.
DU.2: Re-designing of experiment.
DU.3: Observation-qualitative.
DU.4: Observation-quantitative
DU.5: Recording of data
DU.6: Categorization of data
DU.7: Identification, selection and control of variables.
DU.8: Making a hypothesis
DU.9: Precaution during experimentation.
DU.10: Identification and minimisation of error
DU.11: Development of experimental skill.

Post-experiment stage:

PO. 1: Selection of data

PO. 2: Analysis of data-qualitative,-chosing a basis and classification.

PO. 3: Analysis of data-quantitative,calculation

PO. 4: Re-designing of Experiment.

PO. 5: Drawing of graph

PO. 6: Testing of hypothesis

PO. 7: Drawing inference/conclusion

PO. 8: Estimation of error

PO. 9: Generalisation of hypothesis

PO.10: Application to new problems: interpolation, extrapolation.

PO.11: Discovering a law

PO.12: Comparison of relative merits of similar experiment.

# Process-based Practical No.1

| | |
|---|---|
| DISCIPLINE | : Physical Science(Physics) |
| LEVEL | : Class - IX |
| TITLE | : Investigation About Electromagnet |
| Name of the Participants who prepared the draft | : Mr. Nihar Ranjan Mohanty<br>Mr. P.C. Rout |

Title of the Activity: Investigation about electromagnet.

Approximate time required : 45 Minutes

Type of Activity : Individual activity to be conducted in the school.

List of possible processes to be learnt: PR.1, PR2, PR.3, PR.4, PR.7, DU.1, DU.4, DU.5, DU.6, DU.11, PO.1, PO.3, PO.5, PO.6, PO.7.

Pre-requisite Knowledge : A magnetic substance attracts iron filings or nails towards it.

Materials required :

(a) Available:

(i) Nails of different size, alpin, a two feet copper wire.

(b) To be purchased:

(i) 7 batteries each of 1.5V

(c) To be improvised: Nil

Procedure:

STEP: 1:

Teacher's activity: Teacher will instruct the pupils to collect the materials available for investigation about electromagnet.

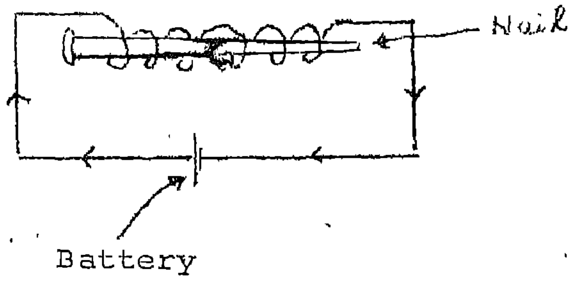
Pupils' activity: Pupils will collect the materials available.

Specific Processes to be learnt: PR.1, PR.2, PR.3

STEP.2:

Teacher's activity: Teacher will instruct the pupils to make an electromagnet with the help of copper wire, nail and battery.

Pupil's activity: Pupils will wound the copper wire over the nail, such that number of turns of the copper wire over the nail is preferably small say five. Then connect the battery to two free ends of the wire so that the electric current flows. The pupils may also think to design an electromagnet in some other way.



Specific processes to be learnt: PR.4, PR.7.

STEP.3:

Teacher's activity: Teacher will instruct the pupils to observe whether the alpins brought near the nail are now attracted by it or not. If yes, then note the observation. The experiment is repeated several times by increasing the number of turns of wire over the nail and the corresponding readings are noted.

Pupil's activity: Pupils will bring the alpins near the nail and note the number of alpins attracted by it when kept end to end. They will repeat the experiment several times by increasing the number of turns of the wire. Wound over the nail and record the number of alpins attracted in a tabular form given below.

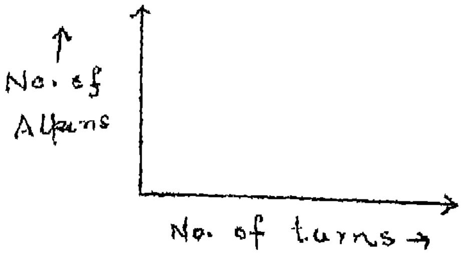
| Sl. No. | No.of battery connected in the circuit (to remain constant) | No.of turns of the wire over the nail | No.of alpins attracted |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |

Specific Processes to be learnt: DU.1, DU.4, DU.5, DU.6, DU.11.

STEP.4:

Teacher's activity: Teacher will ask the pupils to find out if any relation between the variables in Step.2 exists and draw inference.

Pupil's activity: Pupils will plot a graph between the number of turns of the wire versus the number of alpins attracted by the electromagnet and draw inference. That is by increasing the number of turns, number of alpins attracted are increasing or not. If increasing then they can say that strength of the electromagnet is increasing by increasing the number of turns of the wire.



Specific processes to be learnt: PO.1, PO.3, PO.5, PO.6, PO.7.

STEP.5:

Teacher's activity: Teacher will encourage the pupils to redesign the experiment choosing some other quantities as variables.

Pupil's activity: Pupils will make different electromagnets taking different size of the nails, keeping the number of turns of the wire wound over the nails and the number of batteries connected constant. Then they will record the number of alpins attracted in each case in the tabular form given below.

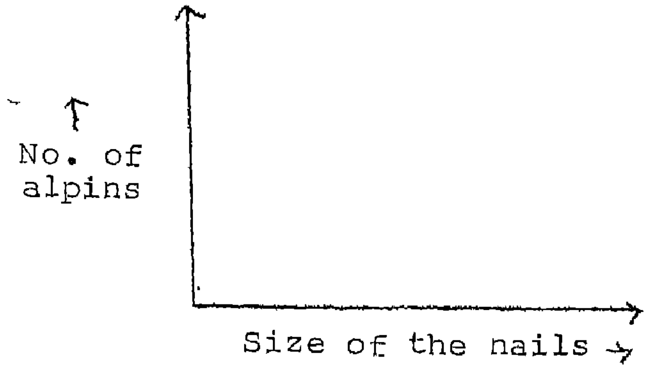
| Sl. No. | No.of turns of the wire | No.of batteries connected | Size of the nail used in the electromagnet. | No.of alpins attracted. |
|---|---|---|---|---|
| | Constant | Constant | | |

Specific processes to be learnt: DU.1, DU.4, DU.5, DU.6, DU.11.

STEP.6

Teacher's activity: Teacher will instruct the pupils to show the relationship between the variables given in Step.4 in a graph and draw inference.

Pupil's activity: Pupils will plot graph between a size of the nails used in the electromagnet versus number of alpins attracted by it which is given below. From the graph they will be able to know that by increasing the size of the nail, the number of alpins attracted by it are increasing or not. Pupil will also learn to apply this idea for making an electromagnet suitable for any purpose.



Specific processes to be learnt: PO.1, PO.3, PO.5, PO.6, PO.7.

STEP.7:

Teacher's activity: Teacher will encourage the pupils to redesign the experiment choosing some other quantities as variable if possible and take observations.

Pupils' activity: Pupils will now keep the number of turns of the wire and the size of the nail constant. Take the readings of number of alpins attracted by changing the number of batteries connected in the circuit and record them in a tabular form given below.

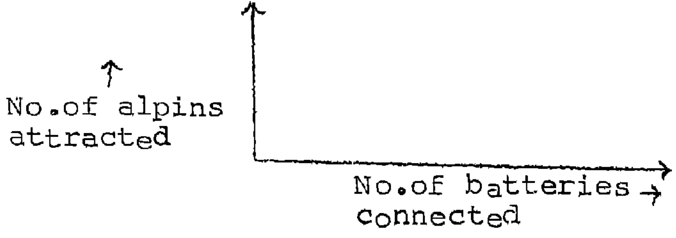
| Sl. No. | No.of turns of the wire | Size of the nail | No. of batteries connected | No.of alpins attracted |
|---|---|---|---|---|
|  | Constant | Constant |  |  |

Specific processes to be learnt: DU.1, DU.4, DU.5, DU.6, DU.11.

STEP.8:

Teacher's activity: Teacher will instruct the pupils to show the relationship between the variable given in Step.6 in a graph and drawn inference.

Pupils' activity: Pupils will plot the graph between number of batteries connected in the circuit versus number of alpins attracted as given below. From the graph they will be able to say by increasing the no. of batteries, the number of alpins attracted towards the electromagnet increases or not. From this idea the pupils will think ways to produce strong electromagnets.



## Process-based Practical No.2

| | |
|---|---|
| DISCIPLINE | : Physical Science (Physics) |
| LEVEL | : Class - IX |
| TITLE OF ACTIVITY | : Investigate about the effect of solute on surface tension of water. |
| Name of the Participant who prepared the draft. | : Mr. Ramani Ranjan Rout |

Title of the activity: Investigate about the effect of solute on surface tension of water.

Approximate time required : 45 minutes

Type of activity : Individual activity to be conducted in the school.

List of possible processes to be learnt. : PR.3, PR.4, PR.7,
DU.1, DU.2, DU.4, DU.5, DU.8
PO.3, PO.5, PO.6, PO.8, PO.10.

Pre-requisite knowledge : Solute, Solution, Surface tension.

Materials required :

(a) Available:

(i) Glass tumbler, (ii) Common salt, (iii) Milk, (iv) Sugar, (v) Soap, (vi) Cap of a bottle, (vii) Broken thermometer (to be used as capilary tube).

(b) To be purchased:

(i) Spirit.

Procedure:

STEP.1:

Teacher's activity: The teacher will instruct the students to collect the materials for the experiment.

Pupils' activity: Students will collect the materials for the purpose.

Specific processes to be learnt: PR.3, PR.4, PR.7.

STEP.2:

Teacher's activity: Teacher will instruct the students to make salt solution of common salt with water of different concentration in separate containers. Similarly sugar solution in water, soap solution in water, spirit solution in water, milk in water keeping the volume of water constant.

Pupils' activity: Students will prepare the salt solution of common salt with water of different concentration in separate containers. Similarly sugar solution in water, soap solution in water, spirit solution in water, milk in water keeping the volume of water constant.

Specific Processes to be learnt: DU.2, DU.4, DU.7.

STEP.3:

Teacher's activity: Teacher will instruct the students to compare the surface tension of different concentration common salt solution in water by observing the height of the solution in the Capilary tube when it is dipped successively in solutions of different concentrations and to record their observations.

Pupils' activity: Students will compare the surface tension of different concentration of common salt solution by observing the height of the liquid using same capilary tube and record them.

Specific Processes to be learnt: DU.1, DU.2, DU.5.

STEP.4:

Teacher's activity: Teacher will instruct the students to compare the surface tension of different concentration of sugar solution in water by observing the height of the solution in the same capilary tube when it is dipped successively in solutions of different concentrations and to record their observations.

Pupils' activity: Students will compare the surface tension of different concentration of sugar solution in water by observing the height of the solutions using the same capilary tube and record them.

Specific Processes to be learnt: DU.1, DU.2,DU.5.

STEP.5:

Teacher's activity: Teacher will instruct the students to compare the surface tension of different concentration of spirit in water by observing the height of the solution in the same capilary tube when it is dipped successively in solutions of different concentrations and to record their observations.

Pupils' activity: Students will compare the surface tension of different concentration of spirit in water by observing the height of the solutions using the same capilary tube and record them.

Specific Processes to be learnt: DU.1, DU.2,DU.5.

STEP.6:

Teacher's activity: Teacher will instruct the students to compare the surface tension of different concentration solution of milk in water by observing the height of the solution in the same capilary tube when it is dipped successively in solutions of different concentrations and to record their observations.

Pupils' activity: Students will compare the surface tension of different concentration solution of milk in water by observing the height of the solutions with the help of same capilary tube and record them.

Specific Processes to be learnt: DU.1, DU.2, DU.5.

STEP.7:

Teacher's activity: Teacher will instruct the students to analyse the data recorded about common salt solution in water, sugar solution in water, spirit solution in water, milk in water and to give the hypothesis.

Pupils' activity: Students will analyse the data recorded about the above solution and they will give the hypothesis - "with increasing concentration of water solution the surface tension increased/decreases/remains constant".

Specific Processes to be learnt: PO.3, PO.6.

STEP.8:

Teacher's activity: Teacher will instruct the students to plot a graph taking weight of the solute in x-axis and height of the corresponding solution in y-axis of different solution stated above.

Pupils' activity: Students will plot the graph taking the weight of solute in x-axis and height of the corresponding solution in y-axis of different solution stated above.

Specific Processes to be learnt: PO.5

STEP.9:

Teacher's activity: Teacher will instruct the students to analyse the graph and to give their conclusion and try to discover a law.

Pupils' activity: Students will analyse the graph of various types of different concentration solution in water. They may give their conclusions in the following forms.

i) From the graph any unknown amount of solute added to the solvent can be known.

ii) Concentration of solution is indirectly propertional to the height of the rise of liquid in the capilary tube.

Specific Processes to be learnt: PO.8, PO.10.

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## Process-based Practical No.3

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|---|---|---|
| DISCIPLINE | : | Physical Science(Physics) |
| LEVEL | : | Class - X |
| TITLE OF ACTIVITY | : | Investigation about the oscillations of simple pendulum. |
| Name of the participant who prepared the draft. | : | Mr. Prasanta Kumar Mohapatra. |

Title of activity: Investigation about the oscillation of Simple Pendulum.

Approximate time required : 1 hr. 30 minutes.

Type of activity : Individual activity to be conducted in the school.

List of possible processes to be learnt. : PR.1, PR.2, PR.3, PR.4, PR.7,
DU.1, DU.2, DU.4, DU.5, DU.6, DU.7,
DU.8,
PO.1, PO.3, PO.5, PO.7.

Pre-requisite knowledge : Simple Pendulum (mass attached to the end of the string).

Materials required:

(a) Available:

(i) a bulk of wood, (ii) Stone,
(iii) a tennis ball, (iv) Iron ball,
(v) A string, (vi) Stop watch.

(b) To be purchased: Nil

STEP.1:

Teacher's activity: Teacher asks the pupils to collect the materials from the sorroundings.

Pupils' activity: Pupils will collect the above materials.

Specific Processes to be learnt: PR.1, PR.2, PR.3

STEP.2:

Teacher's activity: Teacher will instruct the pupils to design the experiment.

Pupils' activity: Pupil will take one body say a block of wood. Tie one end of the string to the wood and suspend it from a rigid support.

Specific Processes to be learnt: PR.4, PR.7.

STEP.3:

Teacher's activity: Teacher will instruct the pupils to record time taken for 20 oscillations of the pendulum and find out time taken for one oscillation.

Pupils' activity: Pupils will note the time taken for 20 oscillations and find out time taken to complete one oscillation and repeat this experiment several times.

Specific Processes to be learnt: DU.1, DU.4, DU.5, DU.7, DU.8.

STEP.4:

Teacher's activity: Teacher will ask the pupils to takedown the reading in a tabular form.

Pupils' activity: Pupils will take the observation as per the table given below:

| Sl. No. | Time for 20 oscillations | Time for 1 oscillation | Mean time period |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |

Specific Processes to be learnt: DU.4, DU.5, DU.6.

STEP.5:

Teacher's activity: Teacher will instruct the pupils to repeat the experiment taking different Pendulum having the same length.

Pupils' activity: Pupil will find out the time period of different pendulum having the same length and note the readings.

Specific Processes to be learnt: DU.2, DU.4, DU.5.

STEP.6:

Teacher's activity: Teacher will instruct the pupils to plot graph between time period versus mass of the Pendulum and draw inferences.

Pupils' activity: Pupils will plot the graph and draw inferences.

Specific Processes to be learnt: PO.1, PO.3, PO.5, PO.7.

STEP.7:

Teacher's activity: Teacher will instruct the students to find out time period of simple pendulum of different lengths and plot graphs.

Pupils' activity: Pupils will find out the time period of simple pendulum of different lengths and plot graph between time period versus length of the Pendulum and draw inferences.

Specific Processes to be learnt: PO.1, PO.3, PO.5, PO.7

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## Process-based Practical No.4

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|---|---|
| DISCIPLINE | : Physical Science(Physics) |
| LEVEL | : Class - VIII |
| TITLE OF ACTIVITY | : Investigation about expansion of liquids. |
| Name of the participants who prepared the draft. | : Mr. Purna Chandra Rout<br>Mr. Abhimanyu Das |

Title of activity: Investigation about expansion of liquids.

Approximate time required : 45 minutes

Type of activity : Group activity to be conducted in the school.

List of possible processes to be learnt : PR.1, PR.3, PR.5, PR.6,
DU.1, DU.3, DU.4, DU.5, DU.6,
DU.9, DU.11,
PO.1, PO.2, PO.4, PO.5, PO.7,
PO.9, PO.12.

Pre-requisite knowledge : Method of making Air-tight bottles.

Materials required:

(a) Available:

(i) Equal size medicine bottles,
(ii) Empty Refills of dot pen,
(iii) Corks,
(iv) Stove,
(v) Scale,
(vi) Water,
(vii) Kerosin
(viii) Coconut oil.

(b) To be purchased: Nil

(c) Improvised: Nil

Procedure:

STEP.1:

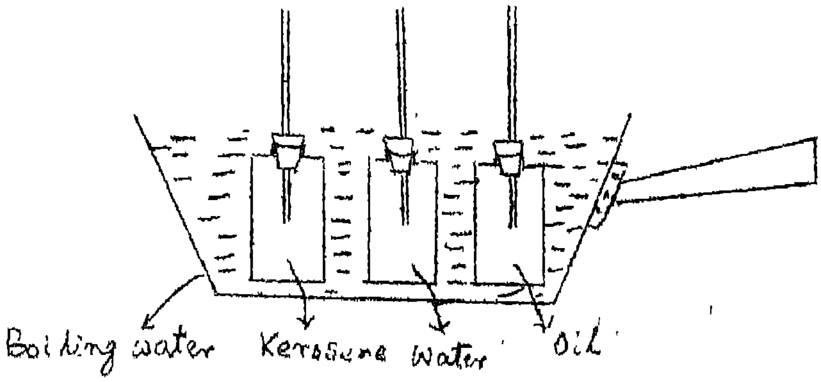
Teacher's activity: Teacher will identify the problem and explain all about expansion of solid, liquid and gas due to heat. He will advice the pupils to collect the materials from their home as listed above.

Pupils' activity: The pupil will collect equal sized bottles, corks and empty refills of dot pen. A pan and a stove. They will clean the bottles and make holes in the corks to fit the refills in the corks.

Specific Processes to be learnt: PR.1, PR.3.

STEP.2:

Teacher's activity: The teacher will design an experiment with the help of the students to study the expansion of liquids like water, kerosin and coconut oil. He will divide them into three groups and demonstrate the method . Each group will study the expansion of three liquids.



Pupils' activity: Three groups will start their experiment having three liquid full bottles fitted with empty refills. The bottles will be made air tight by sealing wax. They will start heating their pans of water over the stove till it boils and immerse the three bottles inside the hot water and observe the rise of liquid through the empty refill attached to the Cork of the bottles.

Specific Processes to be learnt: PR.5, PR.6,
DU.1, DU.3

STEP.3:

Teacher's activity: The teacher will instruct the groups to note the maximum heights due to expansion inside the refills from the top of the Cork with the help of a scale. He will look into every groups reading after a particular time gap, say, 1 minute. He will instruct the pupil to take five such readings after he rings a bell as the teacher must have a watch. He will write the observation table for the pupil to note the readings.

Pupils' activity: Each group will note down the rise of liquids with their scale from the top of the cork each time following teacher's instruction, and record the observation in the following table.

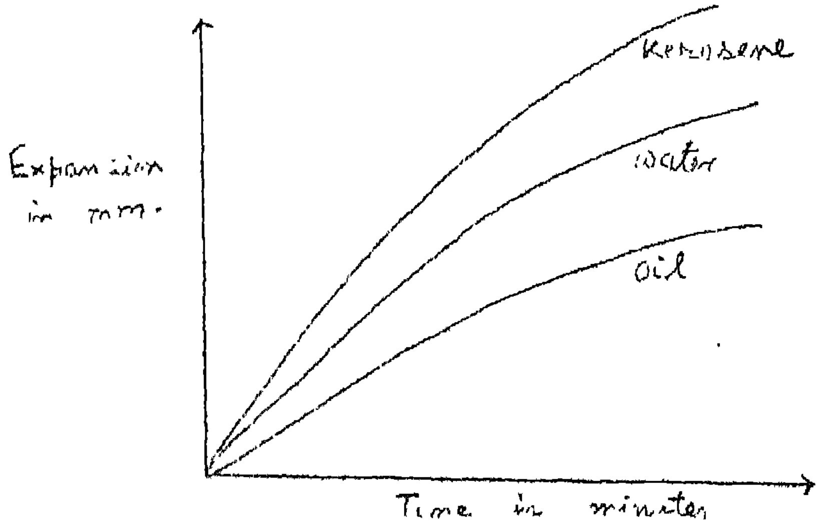
Table

| Sl. No.of obs. | Reading of the top of the liquid level in the refill after | | | | | Actual expansion after | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 min. | 2min. | 3min. | 4min. | 5min | 1min | 2min | 3min | 4min | 5m |
| Water | | | | | | | | | | |
| Kerosene | | | | | | | | | | |
| Coconut Oil | | | | | | | | | | |

Specific Processes to be learnt: DU.4, DU.5, DU.6

STEP.4:

Teacher's activity: Teacher will examine the data noted by each group. He will ask the pupil to compare the expansion in case of different liquids. He will advise the pupil to plot a graph taking time in X-axis and their expansion in m.m in Y-axis and have a comparative idea of expansion.



Pupils' activity: From the data collected the pupil will calculate the actual expansion after each minute/time gap. They will plot graphs as per the instruction given. The expansion curve in each case will give a comparative idea of expansion.

Specific Processes to be learnt: DU.9, DU.11, PO.1, PO.2, PO.5, PO.7.

STEP.5:

Teacher's activity: The teacher will advise the pupil to perform such experiments taking some other available liquids like salt solution, sugar solution, mustard oil.

Pupils' activity: Pupil will collect other liquids or solutions to perform such experiments and will compare their expansion by ploting graphs.

Specific Processes to be learnt: PO.4, PO.9, PO.12

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## Process-based Practical No.5

| | |
|---|---|
| DISCIPLINE | : Physical Science (Physics) |
| LEVEL | : Class - VIII |
| TITLE OF ACTIVITY | : Investigation of number of Images of an object placed in between two inclined plane Mirrors. |
| Name of the participants who prepared the draft. | : Mr. Abhimanyu Das |

Title of activity: Investigation of number of Images of an object placed in between two inclined plane mirrors.

Approximate time required : 1 Hour

Type of activity : Individual activity to be conducted In school or out side.

List of possible processes to be learnt. : PR.1, PR.3, PR.4, PR.6, PR.7. DU.1, DU.3, DU.4, DU.5, DU.6, DU.7 DU.9, DU.10, DU.11, PO.1, PO.3, PO.5, PO.8, PO.9, PO.10 and PO.11.

Pre-Requisite knowledge : Drawing and Measurement of different Angles.

Materials required:

(a) Available:

(i) Two plane mirrors, (ii) A glass marble, (iii) Pencil, (iv) Paper sheet, (v) Protrac (vi) Scale, (vii) Gum etc.

(b) Improvised:

Join two plane mirrors of equal size pasting a gum paper at other side to hinge the mirrors.

(c) To be purchased: NIL

Procedure:

STEP.1:

Teacher's activity: The teacher will ask the students to collect the above materials. He will identify the problem and narrate the idea behind the problem.

Pupils' activity: Each pupil of the class will collect a set of materials as given inthe list. They will make an idea of the problem and think of a method for solution with the help of the teacher.

Specific Processes to be learnt: PR.1, PR.3.

## STEP.2:

Teacher's activity: The teacher will design the procedure for conducting the experiment. He will direct the pupil to join two mirrors by a pasted paper to orm a set of hinged mirrors. He will demonstrate how to place the mirrors on the paper forming a particular angle and place the object ( the marble ) in between the mirrors and observe the Images.

Pupils' activity: Each pupil will take two mirrors and join them with paste and paper. After drying it under sun the pupil will place the double mirror on the paper sheet forming a particular angle. He will place the marble in between the mirrors and observe the images.

Specific Processes to be learnt: PR.4, PR.6.

## STEP.3:

Teacher's activity: The teacher will demonstrate how to draw different angles on paper with the help of a protractor. He will place the mirrors on the two arms of the angles vertically and place the marble in a middle position [illegible]. The teacher will direct the students to draw the following angles for getting different numbers of Images.

15°, 30°, 45°, 60°, 75°, 90°, 105°, 120°

Pupils' activity: Pupils will plot above angles on the paper sheet and keep the double mirror in different position and placing the marble will observe the change in number of Images.

Specific Processes to be learnt: AR.7,
DU.1, DU.3, DU.4,

STEP.4:

Teacher's activity: The teacher will direct the pupil to note the number of images formed correctly in each case in the tabular forms.

Pupils' activity: Pupils will take the first reading on 15° position and count the number of images formed. In this way they will take other observation changing the position of the mirrors from 15° to 120° and note down, in each case, the number of images formed in the tabular form.

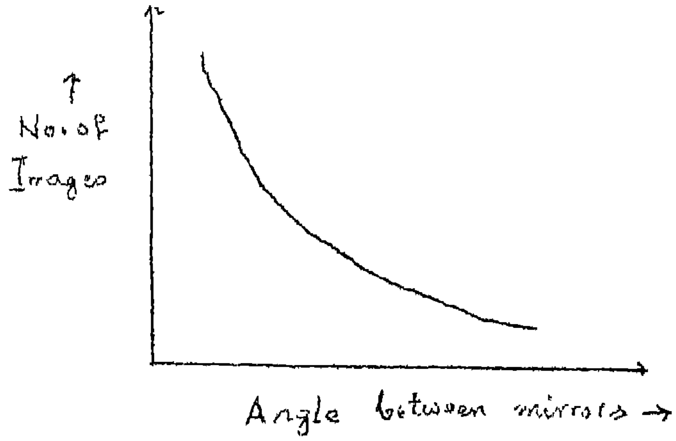
| Sl. No.of Obs. | Abgle in between the mirrors | No. of Images formed | Remarks |
|---|---|---|---|
| 1 | 15° | | |
| 2 | 30° | | |
| 3 | 45° | | |
| 4 | 60° | | |

Specific Processes to be learnt: DU.5, DU.6, DU.7,
DU.9, DU.10, DU.1

STEP. 5:

Teacher's activity: The teacher will guide the students to plot the graph taking the angle in between the mirrors and no. of images formed.

Pupils' activity: Students will take the angle in X-axis and no. of images in Y-axis and plot the graph on a piece of graph paper as shown.



Specific Processes to be learnt: PO.1, PO.3, PO.5.

STEP.6:

Teacher's activity: From the graph and the observations the teacher will try to generalise and may find a relation in between the angle and the number of images. It may be such that

(No. of Images + 1) X (The angle in between the mirrors) = $360^\circ$

Pupils' activity: Students will calculate the value in each case as directed by the teacher. It may come to $360^\circ$ approximately in most of the cases.

Specific Processes to be learnt: PO.7, PO.9.

STEP.7:

Teacher's activity: After generalising the multiplied value he may derive a formula such as the following

Falling "$\theta$" = the angle in between the mirrors.

NI = Number of Images.

$$(NI + 1)\ \theta = 360$$

$$NI + 1) = \frac{360}{\theta}$$

He will direct the students to apply this formula in other situations.

Pupils' activity: Pupils will follow the teacher and derive the formula

$$NI = \left( \frac{360}{\theta} - 1 \right)$$

They will apply the formula for other angles as $36^{o}$, $22^{o}$ etc. and check their calculations by repeating the experiments for these angles.

Specific Processes to be learnt: PO.9, PO.10, PO.1

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## Process-based Practical No.6

DISCIPLINE : Physical Science(Chemistry)

LEVEL : Class - IX

TITLE OF ACTIVITY : Investigation about the action of different flower extracts on acid (hcrmon juice) and alkali (lime water).

Name of the participants who prepared the draft. : Mr.Prasanta Kumar Mohapatra

Title of activity: Investigation about the action of different flower extracts on acid (Lemon Juice) and alkali (Lime water).

Approximate time required : 45 minutes

Type of activity : Individual activity to be conducted inside the school.

List of possible processes to be learnt. : PR.2, PR.3, PR.4,
DU.2, DU.3, DU.5, DU.6, DU.8,
PO.2, PO.6.

Pre-requisite knowledge : Defination of acid,
Defination of alkali,
Defination of indicator,
Role of indicator, or,
Purpose of the use of indicator.

Materials required:

(a) Available:

(a) Various types of flowers of different plants lime water, lemon juice, grinder.

(b) To be purchased: Nil

Procedure:

STEP.1:

Teacher's activity: Teacher will instruct the pupils to collect different types of coloured flowers of different plants.

Pupils' activity: Pupils will collect the flowers ( coloured, colourless available in the environment) and will make a list of the flowers.

Specific Processes to be learnt: PR.2, PR.3, PR.4

**STEP. :**

Teacher's activity: Teacher will instruct the pupils to extract the flower juice of each flower separately and to keep it in separate containers (tea cup) or small pot and paste a lebel on it for identification.

Pupils' activity: Pupils will extract the flower juice and keep them in separate containers and paste lebel on them.

Specific Processes to be learnt: PR.4.

**STEP.3:**

Teacher's activity: Teacher will instruct the pupils to test the different flower extracts using lemon juice and to observe and record the changes those take place.

Pupils' activity: Pupils will add one type of flower extract at a time to lemon juice and record the changes.

Specific Processes to be learnt: DU.2, DU.3, DU.5

**STEP.4:**

Teacher's activity: Teacher will instruct the pupils to test the flower extract using lime water and to observe and record the changes in colour.

Pupils' activity: Pupils' will test the flower extract using lime water. They will observe and record the changes in colour.

Specific Processes to be learnt: DU.2, DU.3, DU.5.

STEP.5:

Teacher's activity: Teacher will instruct the pupils to categorise the observations i.e. changes occured by addition of lemon juice.

Pupils' activity: Pupils' will categoriese the data separately.

Specific Processes to be learnt: DU.6.

STEP.6:

Teacher's activity: Teacher will instruct the pupils to categoriese the observation i.e. changes in colour occured by addition of lime water.

Pupils' activity: Pupils will categoriese the data separately.

Specific Processes to be learnt: DU.6.

STEP.7:

Teacher's activity: Teacher will instruct the pupils to make a table of the action of acid and alkali on the different flower extracts.

Pupils' activity: Pupils will make a table of the action of acid and alkali on the different flower extracts.

Specific Processes to be learnt: DU.5.

STEP.8:

Teacher's activity: Teacher will instruct the pupils to classify the flowers on the basis of the above data.

Pupils' activity: Pupils will do as per the above instruction and draw inferences.

Specific Processes to be learnt: DU.5, DU.8.

## Process-based Practical No.7

| | |
|---|---|
| DISCIPLINE | : Physical Science (Physics) |
| LEVEL | : Class - X |
| TITLE OF ACTIVITY | : Investigation about the Calorific values of different oils. |
| Name of the participants who prepared the draft. | : Mr.Nihar Ranjan Mohanty |

Title of activity: Investigation about the Calorific values of different oils.

Approximate time required. : 1 hour 30 minutes.

Type of activity : Individual activity to be conducted in the school.

List of possible processes to be learnt. : PR.1, PR.2, PR.4,
DU.1, DU.2, DU.4, DU.5, DU.6, DU.7,
DU.8, DU.9, DU.10, DU.11.
PO.1, PO.2, PO.3, PO.5, PO.7,
PO.8, PO.9, PO.10, and PO.11.

Pre-requisite knowledge : Calorific value of the oil is defined as the heat energy liberated in joule when one gram of oil is burnt.

The heat energy liberated can be found out by heating water in a beaker by the formula

$H = MSt + Mt = Wt + Mt = (W + M)\ t$

Since the specific heat of water is equal to unity.

Where

M mass of the water
t rise in temperature of water.
W Water equivalent of beaker.

Materials required:

(a) Available:

Different kinds of oils such as Coconut oil, Caster oil, Kerosene, mobil oil etc., physical balance, beaker and thermometer, lamps.

(b) To be purchased: Nil

(c) To be improvised: Nil

Procedure:

STEP.1:

Teacher's activity: Teacher will instruct the pupils to collect the materials available for conducting the experiment.

Pupils' activity: Pupils will collect the materials.

Specific Processes to be learnt: PR.1, PR.2, PR.4.

STEP.2:

Teacher's activity: Teacher will instruct the pupils to find out the masses of the oils taken in different lamps.

Pupils' activity: Pupils will measure the masses of empty lamps and then measure the masses of the lamps containing the oils. The difference of the above two masses will give the masses of the oils taken in the different lamps.

Specific Processes to be learnt: DU.1, DU.4, DU.5.

STEP.3:

Teacher's activity: Teacher will instruct the pupils' to take a beaker approximately half filled water and determine its mass.

Pupils' activity: Pupils will take mass of the empty beaker and then take the mass of the beaker containing water. The difference between the two gives the mass of the water taken.

Specific Processes to be learnt: DU.1, DU.4, DU.5.

STEP.4.

Teacher's activity: Teacher will ask the pupils to heat the beaker containing water using one of the oil lamps and observe the rise in temperature using a thermometer. They will take proper precaution during heating.

Pupils' activity: Pupils will heat the beaker containing water using one of the oil lamps. They will have to see that the flames of the lamp are not wasted. This can be done by covering all the sides of the lamp by any type of cover designed by the pupil. The cover should have small holes for the air to enter. In this step pupils will also observe the rise in temperature of the water.

Specific Processes to be learnt: DU.1, DU.7, DU.9, DU.10, DU.11.

STEP.5:

Teacher's activity: Teacher will instruct the pupils to note the rise in temperature of the water, when it has risen appreciably and extinguish the lamp.

Pupils' activity: Pupils will find out the rise in temperature of the water by substracting the initial temperature of the water before heating from its final temperature after the lamp is extinguished. The maximum temperatures attained by the water will be recorded as its final temperature for accuracy since the temperature of the water may rise after extinguishing the lamp.

Specific Processes to be learnt: DU.4, DU.5, DU.9, DU.10, DU.11.

**STEP.6**

**Teacher's activity:** Teacher will instruct the pupils to find the mass of oil consumed in combustion in order to heat the water.

**Pupils' activity:** Pupils will measure the mass of the lamp after it is extinguished and hence find the mass of the oil consumed which will be equal to(the mass of the lamp containing oil before lighting) - (mass of the lamp containing oil after it is extinguished).

**Specific Processes to be learnt:** DU.4, DU.5.

**STEP.7:**

**Teacher's activity:** Teacher will instruct the pupils to record the data found out in the above steps in a tabular form given below and repeat the experiment using different kinds of oil.

**Pupils' activity:** Pupils will record the data for different oils in the table given below.

| Sl. No. | Name of oils | Mass of the empty lamp ($M_1$) | Mass of the lamp containing oil before lighting ($M_2$) | Mass of the oil taken in the lamp $M_3 = M_2-M_1$ | Mass of the lamp containing oil after it is extinguished $M_4$ | Mass of oil consumed in heating the water $M_5 = M_2-M_4$ | Initial temp. of the water in °C $t_1$ |
|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |

| Final temp. of the water in °C $t_2$ | Rise in temperature in °C $t = t_2 - t_1$ | Rise in temp. per unit mass of the oil consumed in heating the water $\frac{t}{M_5}$ |
|---|---|---|
| 9 | 10 | 11 |

Specific Processes to be learnt: PO.1, PO.2, PO.3

STEP.8:

Teacher's activity: Teacher will ask the pupils to draw inference from the data recorded in STEP.7.

Pupils' activity: Pupils will be able to say that the calorific values of the oils is proportional to rise in temperature of the water per unit mass of the oil consumed in heating. From this idea pupil will be able to arrange the oils in increasing order of their calorific values and use them for different purposes in day to day life.

Specific Processes to be learnt: PO.7, PO.8, PO.9, PO.10, PO.11.

STEP.9:

Teacher's activity: Teacher will instruct the pupils to redesign the experiment and record the rise in temperature of different amount (mass) of water heated keeping the mass of the particular kind of oil constant. This experiment can be repeated taking different kinds of oil.

Pupils' activity: Pupils will take different amount of water and measure the rise in temperature when heated keeping the mass of the particular kind of oil burnt constant in each case and record them in a tabular form as given below. In this step, pupils will think different ways to keep the mass of the oil burnt constant and apply the way suitable to them.

| Sl.No. | Mass of the water taken in the beaker. | Rise in temperature when a constant mass of the oils is burnt. |
|---|---|---|
| | | |

For each kind of oil, data will be recorded in separate table.

Specific Processes to be learnt: DU.2, DU.1, DU.[illegible], DU.4, DU.5, DU.7, DU.8.

STEP.10:

Teacher's activity: Teacher will instruct the pupils to apply the formula for energy liberated in heating water in a beaker and recorded data in Step.9 to find out the calorific value of the oil used and water equivalent of the beaker as given below.

We know that,

$$Q = (m + M)\ t$$

(as given in para "Pre-requisite knowledge" which is equal to Mo times the Calorific values of the oil (K): Where Mo is the mass of the oil burnt.)

$$\text{Hence} \quad Q = (m + M)\ t = Mo\ K$$

$$m = -M + \frac{KMo}{t} \qquad \text{— (A)}$$

Since in equation (A) $m$ and $t$ are variables and their variations are already recorded in Step.9, pupils can plot graph between $m$ versus $\frac{1}{t}$.

And from the graph they will be able to find out the Calorific value and water equivalent of beaker.

Pupils' activity: Pupils will plot graph between $m$ versus $\frac{1}{t}$ [illegible]. The slope of the graph will give the value KMo from which Calorific value of the oil can be found out and the absolute value of the Y-intercept of the graph will give the water equivalent of the beaker.

Specific Processes to be learnt: PO.3, PO.5, PO.7, PO.10, PO.11.

## Process-based Practical No.8

| | | |
|---|---|---|
| DISCIPLINE | : | Physical Science(Physics) |
| LEVEL | : | Class - X |
| TITLE OF ACTIVITY | : | Investigation about the work done for compressing a Spring through different distances. |
| Name of the participants who prepared the draft. | : | Mr.Nihar Ranjan Mohanty |

| | |
|---|---|
| Title of activity: | Investigation about the work done for compressing a spring through different distances. |
| Approximate time : required. | 1 hour |
| Type of activity : | Individual activity to be conducted in the School. |
| List of possible : processes to be learnt. | PR.1, PR.2, PR.3, PR.4, PR.7, DU.1, DU.3, DU.4, DU.5, DU.6, DU.7, DU.8, DU.9, DU.10, DU.11. PO.1, PO.3, PO.5, PO.7, PO.9, and PO.10. |
| Pre-requisite knowledge. | Work done = Force X distance moved along the line of action of the force. or W = F X S |

Materials required:

(a) Available:

Known weights (50g, 100g, 200g, 500g, 1 Kg, 2 Kg. etc. depending on the spring), a wooden base, a card board, a scale etc.

(b) To be purchased: A spring

(c) To be improvised:

A pan balance as explained in the procedure.

Procedure

STEP.1:

Teacher's activity: Teacher will instruct the pupils to collect the materials required.

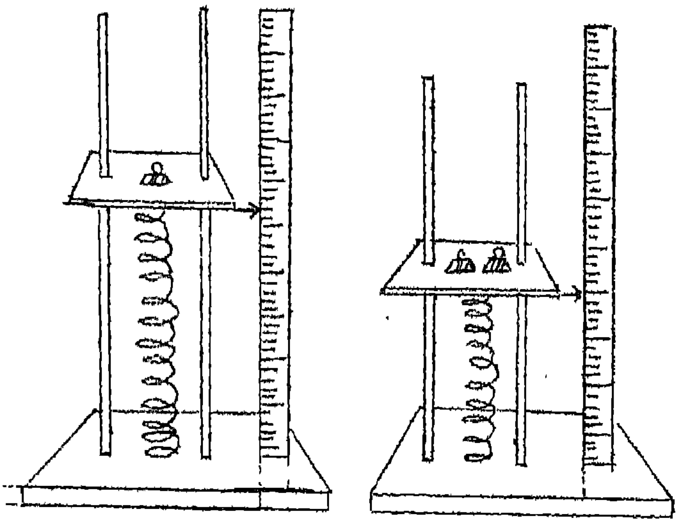
Pupils' activity: Pupils will collect the materials mentioned under para "Materials required".

Specific Processes to be learnt: PR.1, PR.2, PR.3.

STEP.2:

Teacher's activity: Teacher will help the pupils to design the experiment.

Pupils' activity: Pupils will make the arrangements as shown in the diagram given below or design it in some other way.



Specific Processes to be learnt: PR.4, PR.7

STEP.3:

Teacher's activity: Teacher will guide the pupils to take observation while performing the experiment.

Pupils' activity: Pupils will note the initial position of the spring. Then put some known weights on the cardboard over the spring, so that the spring is depressed a little and the reading of the new position of the spring is recorded. Pupil will continue this process by increasing the weights on the spring and will note the corresponding readings which are recorded in tabular form in Step.4. They may be encouraged to think about the maximum and the minimum weights required to perform the experiment. They may also learn TO minimise the errors in their observation.

Specific Processes to be learnt: DU.1, DU.3, DU.4, DU.5, DU.9, DU.11.

STEP.4:

Teacher's activity: Teacher will instruct the pupils to record observations taken in Step.3 in tabular form.

Pupils' activity: Pupils will record the observations in the table given below.

| Sl. No. | Position of spring in CM without putting the weights over it ($S_1$) | Amount of weights placed on the spring in Kg wt. ($W_1$) | Force in Newton exerted on the spring (F) | Position of spring in CM when weights are placed on it. ($S_2$) | Distance in CM through which spring is depressed $S = S_2 - S_1$ | Work done on the spring $W = F \times S$. |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

Specific processes to be learnt: DU.5, DU.6, DU.7, DU.8, DU.11.

STEP.5:

Teacher's activity: Teacher will ask the pupils to identify the errors and suggest ways to minimise the errors.

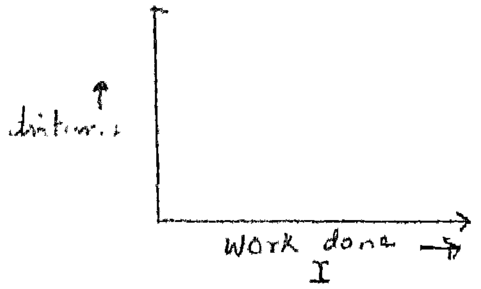
Pupils' activity: Pupils must know that the cardboard placed on the spring should be such that it must not depress the spring when put over it.

Specific processes to be learnt: DU.10

STEP.6:

Teacher's activity: Teacher will ask the pupils to observe the work done calculated for compressing through different distances and to plot the graph between the two and draw inferences.

Pupils' activity: Pupils will plot the work done calculated in Step.4 versus the distances through which spring is depressed, and draw inference.

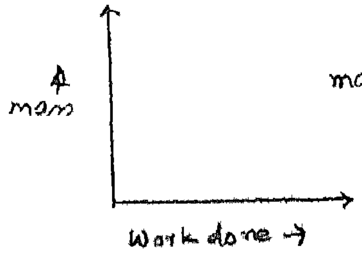


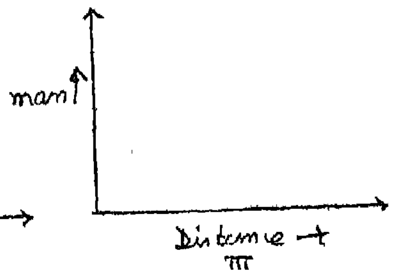
Specific processes to be learnt: PO.1, PO.3, PO.5, PO.7.

STEP.7:

Teacher's activity: Teacher will ask the pupils to plot graphs between other different variables involved in the experiment and draw inference.

Pupils' activity:- Pupils will plot graphs between work done versus mass kept on the spring and between distance through which the spring is depressed versus mass kept on the spring. From the above graphs they will draw inferences.



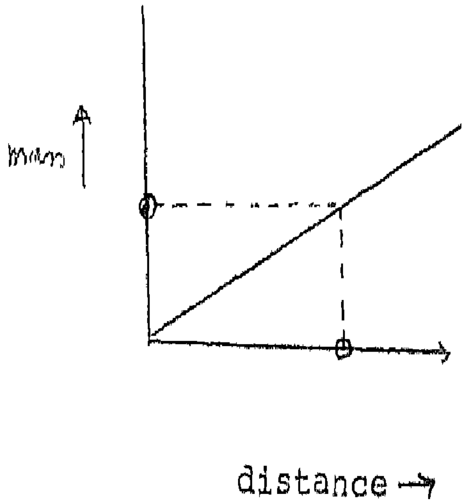


Specific processes to be learnt: PO.1, PO.3, PO.5, PO.7.

STEP.8:

Teacher's activity: Teacher will ask the pupils to find out the mass of any body like a stone or a piece of stone, if kept on the spring using the graph III mentioned in Step.7.

Pupils' activity: Pupils will find out the distance through which the spring is depressed when the body is kept on the spring. Then from the X-axis draw a line parallel to the Y-axis to meet the graph. Then from the point on the graph draw perpendicular on Y-axis. The point of intersection on the Y-axis will give the mass of the body as shown in graph IV below.



IV

Specific processes to be learnt: PO.7, PO.10, PO.9

## Process-based Practical No.9

| | |
|---|---|
| DISCIPLINE | : Physical Science(Physics) |
| LEVEL | : Class - IX |
| TITLE OF ACTIVITY | : Investigation about the density of different woods. |
| Name of the participants who prepared the draft. | : Mr. Gopal Krishna Bebortha |

Title of activity: Investigating about the density of different woods.

Approximate time required : 45 minutes

Type of activity : Group activities in school.

List of possible processes to be learnt. : PR.1, PR.2, PR.4,
DU.1, DU.4, DU.5, DU.8, DU.11,
PO.3, PO.5, PO.6, PO.7, PO.11,
PO.12.

Pre-requisite knowledge :

(1) The pupils have knowledge about different kinds of wood available in the locality.

(2) They have knowledge about measurement of mass and volume .

(3) Density = $\frac{\text{Mass}}{\text{Volume}}$

Materials required:

(a) Available:

(i) Teak wood, (ii) Sal, (iii) Piasal, (iv) Sisua, (v) Gambhari.of same length.

(b) To be purchased:

(i) A measuring plastic cylinder.

(c) To be improvised:

(i) An improvised balance and some tamarind seeds of same weight (approximately) and a thread of two meters length.

Procedure:

STEP.1:

Teacher's activity: The teacher will ask some students to collect different types of wood and ask them to cut each of them to uniform size of same length.

Pupils' activity: Some of the pupils will do according to the suggestions given by the teacher.

Specific processes to be learnt: PR.4, PR.5,PR.7

STEP.2:

Teacher's activity: The teacher will ask some students to bring two lids of empty Zarda tins (size being same), a wiring pipe of 20 cms. length. He suggests the pupils to prepare an improvised balance giving them the two tin lids, a thread of about one meter and a nail. Further he asks the students to bring some tamarind seeds of uniform size to be used as weight (Different coins can also be used as weight).

Pupils' activity: The pupils prepare an improvised balance. At first they make three holes at equal distances inthe edge of the lid and tie them with three pieces of string and finally put a knot of the three strings at the other end. Similarly they do this in the other lid and keep the length of string same to that of the first they have used. Now they make a hole at the centre of the pipe and two holes are made equidistant from the centre at both end. Now they insert the knot through these holes at both ends of the pipe. A string piece is also introduced at the central hole of the pipe that acts as the fulcrum. They collect some tamarind seeds to be used as weight.

Specific processes to be learnt: PR.4, PR.5,PR.7

STEP.3:

Teacher's activity: The teacher will ask students one by one to measure the mass of each wood with the help of the improvised balance and record the number of tamarind seeds being used as weight.

Pupils' activity: The pupils weigh each of the wood and record the number of seeds counter balanced in each case.

Specific processes to be learnt: DU.4, DU.5, DU.6.

STEP.4:

Teacher's activity: The teacher will ask the pupils to tie each of the wood by a string and immerse them one by one in a measuring jar containing water after noting down the initial level and asks them to note down the final level of water in each case.

Pupils' activity: The pupils do the same as suggested by the teacher one after another and note down the final reading of water level.

Specific processes to be learnt: DU.4, DU.5, DU.6

| Sl. No. | Type of wood | Mass X in units of seeds | Volume Y | No. of seeds | Density X/Y |
|---|---|---|---|---|---|
| 1. | Teak | - | - | | |
| 2. | Sal | - | - | | |
| 3. | Piasal | - | - | | |
| 4. | Sisu | - | - | | |
| 5. | Gambhari | - | - | | |

STEP.5:

Teacher's activity: The teacher asks the pupils to investigate about the density of different woods so taken.

**Pupils' activity:** The pupils get density of each wood by applying the formula mass/volume and density in units like no. of seeds/c.c.

**Specific processes to be learnt:** DU.4, DU.5, DU.8

**STEP.6:**

**Teacher's activity:** The teacher will ask the pupils to analyse and arrange density of different woods so taken in ascending order of their densities.

**Pupils' activity:** The pupils will find that volume remaining constant the wood that has more mass has more density and that which has less mass has less density. The pupils will analyse and find that different woods having different mass have different density.

**Specific processes to be learnt:** PO.6, PO.7, PO.11, PO.12.

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## Process-based Practical No.10

| | |
|---|---|
| DISCIPLINE | : Physical Science(Physics) |
| LEVEL | : Class - VIII |
| TITLE OF ACTIVITY | : Investigation of Radiation/ Absorption abilities of different colours. |
| Name of the participants who prepared the draft. | : Preeti Lata Jena |

Title of activity: Investigation of radiation/absorption abilities of different colours.

Approximate time required : 3 hours.

Type of activity : Group activity to be conducted in the school.

List of possible processes to be learnt. : PR.1, PR.3, PR.4, [illegible], PR.6, DT.1, DT.[illegible], [illegible], [illegible], DT.9, DT.11, FO.1, FO.[illegible], [illegible], [illegible], FO.7, FO.9, FO.10.

Pre-requisite knowledge : Pupils may know about heat and temperature and conduction, convection and radiation of heat.

Materials required:

(a) Available:

(i) Bottles of same size, (ii) Thermometer
(iii) Water, (iv) Gum/thread.

(b) To be purchased:

(i) Pieces of cloths of different colours.

Procedure:

STEP.1:

Teacher's activity: Teacher tells that we will investigate the absorption/radiation abilities of different colours and asks the pupils to formulate hypothesis regarding the problem.

Pupils' activity: Each pupil will formulate his own hypothesis and note it down in the note book.

Specific processes to be learnt: PR.1, PR.3

STEP.2:

Teacher's activity: Teacher instructs the pupils to collect materials required for the experiment.

Pupils' activity: Pupils will collect several bottles of same size, water, pieces of different coloured cloths, gum/thread, thermometer. Some pupils may collect coloured bottles for which coloured cloths are not required.

Specific processes to be learnt: PR.4

STEP.3:

Teacher's activity: Teacher asks the pupils to list the precautions they should take:

Pupils' activity: Pupils will clean the bottles and wipe the outerside of the bottle so that no water remains on the outer surface because it will affect absorption of heat.

Specific processes to be learnt: PR.5

STEP.4:

Teacher's activity: Teacher guides the pupils to arrange the apparatus for the experiment.

Pupils' activity: Some pupils may take the cleaned bottles and put gum at the outer surface. Then they may paste one coloured cloth to the bottle covering the bottle completely only leaving the mouth. They may keep one bottle without covering anything. Then the bottles are allowed to dry. Some pupils may suggest that instead of covering the bottles with coloured cloths we may colour the bottles with different coloured paints.

Pupils will pour one measured amount (it may be one glass) of water to each bottle. Pupils may tell that measured amount of water is required to keep the volume of water in each bottle same. They have to see that while pouring water in the bottle it should not get drenched.

Specific process to be learnt: PR.4, PR.5, PR.6.

STEP.5:

Teacher's activity: Teacher devides the pupils into two groups. Group A will investigate about the absorption of heat and Group B will investigate about radiation of heat. Then the teacher gives instructions to start the experiment under his supervision.

Pupils' activity: Group A pupils will take the various coloured bottles filled with water and measure the temperature of the water in each bottle. Then they will put one bottle in the sunlight for 30 minutes and then note down the temperature of the water inside the bottle. They are to then repeat the procedure with each of the bottles. However the activity can also be completed in just half an hour if enough number of thermometers are available.

Group B on the other hand will note the temperature of the water in each bottle and then bring the bottles into the shade. Wait for 30 minutes and then measure the temperature of the water in each bottle.

Specific processes to be learnt: DU.1, DU.4, DU.9, DU.11.

STEP.6:

Teacher's activity: Teacher guides pupils to record the observation in a tabular form.

Pupils' activity: Pupils prepare a table to note down the data they have obtained from the experiment.

Table

| Sl. No. | Name of the colour of the bottle | Temp. of the water before keeping in sunlight. A | Temp.of the water after keeping in sunlight for 30 minutes. B | Temp. of the water after keeping in room temp. for 30 minutes C | B - A | B - C |
|---|---|---|---|---|---|---|
| 1 | Green | | | | | |
| 2 | Red | | | | | |
| 3 | | | | | | |
| 4 | | | | | | |

Specific processes to be learnt: DU.5, DU.6

STEP.7:

Teacher's ac-tivity: The teacher gives instruction to analyse and interprete the data.

Pupils' activity: Pupils who have recorded the data in a tabular form go through it. The difference of temperature of A and B gives a measure of the heat absorbed by a particular colour. Where the difffference is more that colour absorbs more heat and where it is less that colour absorbs less heat.

Difference B and C gives a measure of the heat lost due to radiation. In the case where B - C is more radiation is more and in the case where B - C is less radiation is less. From this the colour which radiates fast can be found out by the students.

Specific processes to be learnt: PO.1, PO.2,PO.3.

STEP.8:

Teacher's activity: Teacher asks the pupils to verify their own hypothesis from the analysis.

Pupils' activity: Each pupil verifies his hypothesis from the result and rejects those hypothesis which are not correct.

Specific processes to be learnt: PO.6

STEP.9:

Teacher's activity: Teacher guides the pupils to draw conclusion and generalise the result.

Pupils' activity: Each pupil draws his own conclusion after verifying the result and arrive at a generalization regarding the comparative ability of colours to absorb and radiate heat.

Specific processes to be learnt: PO.7, PO.9

STEP.10:

Teacher's activity: Teacher asks the pupils to suggest how the generalization can be applied in day to day life.

Pupils' activity: Pupils may suggest some applications regarding use of lighter colours and darker colours under specific life - centered conditions.

Specific processes to be learnt: PO.10

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## Process-based Practical No.11

| | |
|---|---|
| DISCIPLINE | : Physical Science(Physics) |
| LEVEL | : Class - IX |
| TITLE OF ACTIVITY | : Investigation about the effect of pressure on the volume of a gas in a vessel. |
| Name of the participants who prepared the draft. | : Preeti Lata Jena |

| | |
|---|---|
| Title of activity: | Investigation about the effect of pressure on the volume of a gas in a vessel. |
| Approximate time required : | 2 Hours |
| Type of activity : | Activity can be an individual or group activity to be done in school and outside school. |
| List of possible processes to be learnt. : | PR.1, PR.2, PR.3, PR.4, PR.5, PR.6, PR.7.<br>DU.1, DU.3, DU.4, DU.[illegible], DU.9, DU.11, DU.6.<br>PO.3, PO.5, PO.6, PO.7, PO.9, PO.10, PO.11, PO.12. |
| Pre-requisite knowledge | Student may have knowledge about pressure, force and states of matter. |

Materials required:

(a) Available:

(i) Weights of different measures,
(ii) Wax, (iii) A stand to fix the syringe.

(b) To be purchased:

(i) 1.5 to 2 cm diameter thick glass syringe.

Procedure:

STEP.1:

Teacher's activity: Teacher tells the pupils that we will investigate about the effect of pressure on volume of a gas in a vessel and asks the students to formulate hypothesis on the problem.

Pupils' activity: Each pupil will formulate his own hypothesis and write down them on the note book.

Specific processes to be learnt: PR.1,PR.2,PR.3.

STEP.2:

Teacher's activity: Teacher will ask the pupils to collect the materials required for the experiment.

Pupils' activity: Pupils will collect the weights of different measures, a thick glass syringe about 2 cm diameter, wax to seal the opening of the syringe and a stand where the syringe can be fixed in a vertical manner.

Specific processes to be learnt: PR.4.

STEP.3:

Tea-cher's activity: Teacher instructs the pupils to design - the experiment and supervises the work and also aks them to take necessary precautions.

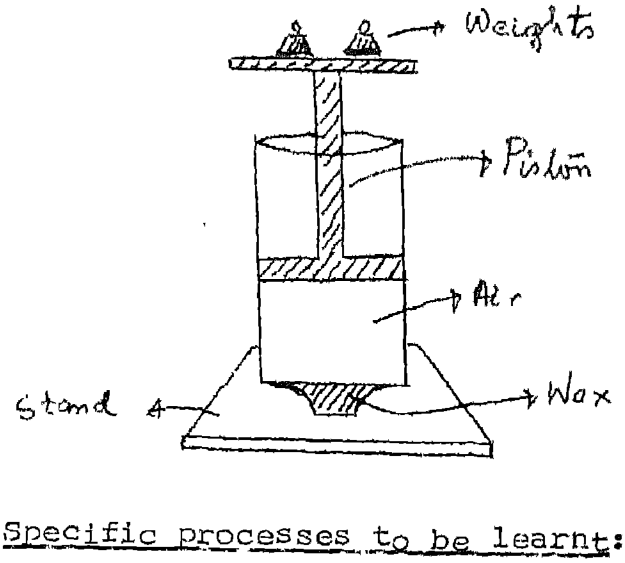
Pupils' activity: Pupils will take the syringe, fill the syringe with air upto 3/4the of the capacity. Then they will seal the opening of the syringe with wax. It is the opening at the front side where usually the needle is attached. Then they will fix the syringe on the stand vertically keeping the sealed side down wards. While sealing they have to take care that the hole is sealed, air-tight, otherwise air will leak out when some weight is kept on it. And also while fixing they must make sure that the syringe will not fall down when weight is kept on the piston.

Specific processes to be learnt: PR.4,PR.5, PR.6, PR.7.

STEP.4:

Teacher's activity: Teacher will guide the pupils to carry out the experiment and tell them to record the readings while doing the experiment.

Pupils' activity : Pupils will start the experiment by taking the initial reading of the syringe. The syringe is graduated and the readings will be taken in "ml". Then pupils will put that much weight on the piston as is sufficient to push the piston in by approximately 1 ml. They will record the weights put on the piston and the new volume of the air inside the syringe. They will repeat the experiment by putting more and more weight on the piston and recording the new volume of the air inside. They are to continue the process till the volume of the air inside the syringe becomes almost half its initial volume.



Specific processes to be learnt: DU.1, DU.3, DU.4, DU.5, DU.9, DU.11.

STEP.5:

Teacher's activity: Teacher will instruct the pupils to record the data in a tabular form.

Pupils' activity: Pupils will make a table and record the readings of the experiment.

| Serial No. | Weights in Kgs. | Volume of air in the syringe in ml. |
|---|---|---|
| 1 | 0 Kgs. | |
| 2 | | |
| 3 | | |
| 4 | | |
| | | |

Specific processes to be learnt: DU.4, DU.5, DU.6.

STEP.6:

Teacher's activity: Teacher will ask the students to analyse the data and plot a graph by taking weights in one axis and the volume of air in the other axis.

Pupils' activity: Pupils' will draw a graph by taking volume of air in x-axis and weights in Y-axis. Pupils may find out from the graph the volume of air when there is zero weight on the piston and note that with increase of weights on the pan the volume of the air inside the syringe decreases. Pupils find out from the graph the weight that is to be put on the piston to decrease the volume of air by a given amount, say 1 ml. Pupils may [illegible] draw a graph between weight put on the piston and inverse of the corresponding volume of the air. Using the graph so drawn they may be led to arrive at the equation

$$W = W_o + \frac{C}{V} \qquad \text{------(1)}$$

where,

$W$ = Weight on the piston

$V$ = Volume of air

and $W_o$ & $C$ are constants.

Specific processes to be learnt: PO.2, PO.3, PO.5

STEP.7:

Teacher's activity: Teacher will ask the students to verify the hypotheses they have formulated.

Pupils' activity: Each pupil will verify the hypothesis he has formulated and reject those hypotheses which are not true.

Specific processes to be learnt: PO.6.

STEP.8:

Teacher's activity: Teacher will instruct and guide the pupils to draw conclusion, arrive into a generalisation and suggest for its application as other fields.

Pupils' activity: Pupils will interpreate the result as expressed in equation-1 and may come to the conclusion that when there is more weight on the piston the volume of the gas decreases. In other words they may suggest when pressure increases the volume of the gas decreases. Also they may report any other conclusion they may arrive at.

Specific processes to be learnt: PO.7, PO.9, PO.10.

STEP.9:

Teacher's activity: Teacher will ask the pupils design new experiments on the same problem and relate it to other experiments.

Pupils' activity: Pupils may suggest new ways of doing the experiment. They may experiment with same syringe instead of putting weights they can pull out the piston and see the result.

Specific processes to be learnt: PO.10, PO.12.

## Process-based Practical No.12

| | |
|---|---|
| DISCIPLINE : | Physical Science(Chemistry) |
| LEVEL : | Class - VIII |
| TITLE OF ACTIVITY : | Investigation about the process of rusting of iron. |
| Name of the participants who prepared the draft. : | Mr. Abhimanyu Das |

Title of activity: Investigation about the process of rusting of iron.

Approximate time required : 35 days.

Type of activity : Group activity to be conducted in the school.

List of possible processes to be learnt. : PR.1, PR.2, PR.4, PR.5, DU.1, DU.3, DU.4, DU.5, DU.6, DU.7, DU.9, DU.10, DU.11, PO.1, PO.2, PO.5, PO.7, PO.9, PO.10, PO.12.

Pre-requisite knowledge : Method of taking weight by a physical balance.

Materials required:

(a) Available:

(i) A physical balance and a weight box, (ii) Water pot, (iii) A stove, (iv) Water, (v) Blotting paper, (vi) An iron plate, (vii) A piece of iron, (viii) An iron nail ( 4" size ).

(b) To be purchased: Nil

(c) To be improvised: Nil

Procedure:

STEP.1:

Teacher's activity: The teacher will arrange a physical balance and a weight box from his school laboratory or from a shop. He will advice the pupils to collect an iron plate, a piece of iron and a nail from their home. He will identify and narrate the problem clearly and divide the students in 3 groups. He will chose the group leader and assign duty to each boy of the group so that all of them will get proper engagement.

Pupils' activity: Pupils will try to comprehend the problem and collect the required materials from their home. The three group members will know their individual duties.

Specific processes to be learnt: PR.1, PR.2.

STEP.2:

Teacher's activity: The teacher will design the experiment and make the students understand the method of weighing. He will demonstrate and point out the precautions while weighing. He will assign Group I to test rusting caused in iron when placed in open air space, Group II to test rusting caused inside water and Group III to test rusting inside boiled (without air/ water. Precautions are to be taken while taking the weight of wet iron pieces. They will dry up the pieces by blotting paper before weighing.

Pupils' activity: The pupils will notedown the precautions. Each group will make their iron material shining by rubbing with sand paper and then find out the weight of the iron pieces assigned to each group.

Specific processes to be learnt: PR.4, PR.5.

STEP.3:

Teacher's activity: The teacher will help the groups to take correct weight. He will advice the pupils to note the initial weight of the iron.pieces. He will ask the pupils to make a tabular form as given below and note down the weights of the same iron piece without making it clean after a gap of seven days.

Pupils' activity: Pupils will take the weight of the rustless iron and note the initial weight in their note book. They will tabulate the weights after each gap period as given below.

Table

| No.of observations | Date of observations | Weight of iron | Difference of weight | Remarks |
|---|---|---|---|---|
| 1 | 1st day | $W_1$ | | |
| 2 | 8th day | $W_2$ | $W_2 - W_1$ | |
| 3 | 15th day | $W_3$ | $W_3 - W_1$ | |
| 4 | 22nd day | $W_4$ | $W_4 - W_1$ | |

Specific processes to be learnt: DU.1, DU.3, DU.4, DU.5.

STEP.4:

Teacher's activity: Teacher will ask the pupils to find out the difference of each weight from the initial weight.

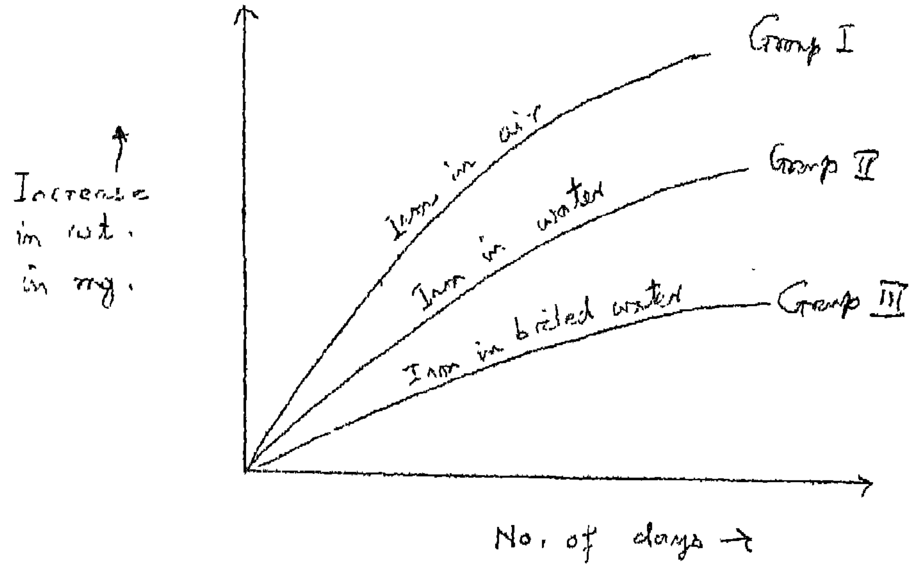
Pupils' activity: Pupils will calculate the difference in weight as per the teachers advice They will put these values in the tabular form. Each group will prepare a table in respect of the iron piece given to it.

Specific processes to be learnt: DU.6, DU.7,DU.9.

STEP.5:

Teacher's activity: The teacher will direct the pupil to trace a graph taking the days in X-axis, increase in weight in Y-axis . He will ask the pupils to draw inferences.

Pupils' activity: Pupils will plot the graph as per the advice of the teacher and pupils may draw inferences about the rusting in each case.



Specific processes to be learnt: PO.1, PO.3, PO.5, PO.7.

STEP.6:

Teacher's activity: The teacher will ask the pupils to compare the three curves and generalise any hypotheses, formulated previously.

Pupils' activity: Each group will compare their graph with the other. They will generalise the hypotheses.

Specific processes to be learnt: PO.7, PO.9, PO.10, PO.12.

STEP.7:

Teacher's activity: Teacher will ask the pupils to make a list of cases where they have seen rusting take place in daily life and suggest procedures to prevent rusting.

Pupils' activity: Pupils will prepare a list of life centered examples of rusting and state processes to prevent rusting.

Specific processes to be learnt: PO.6, PO.9.

## Process-based Practical No.2

| | |
|---|---|
| DISCIPLINE | : Physical Science(Chemistry) |
| LEVEL | : Class - X |
| TITLE OF ACTIVITY | : Classification of substances available in the kitchen. |
| Name of the participants who prepared the draft. | : Mr. Ramani Ranjan Rout |

Title of activity: Classification of substances available in the kitchen.

Approximate time required : 2 hours.

Type of activity : Individual activity to be conducted in the school.

List of possible processes to be learnt. : PR.3, PR.4, PR.7.
DU.1, DU.2, DU.3, DU.4, DU.5,
DU.6, DU.8, DU.9,
PO.2, PO.6.

Pre-requisite knowledge : Organic, inorganic, alkaline and acidic substances.

Materials required:

(a) Available:

Rice, dal, flour, sugar, common salt, coconut oil, mustard oil, kerosene oil, patato, lemon, slaked lime, washing powder, cap of a bottle (metalic), spoon, matches, lamp.

(b) To be purchased:

Iodine, Potasium Iodide solution.

Procedure:

PHASE- I (All the substances)

STEP.1:

Teacher's activity: Teacher will instruct the pupils to collect the materials required.

Pupils' activity: Pupils will collect the materials required and note down in a sheet of paper marked as 'T$_1$', alphabetically.

Specific processes to be learnt: PR.3,PR.4,PR.7

STEP.2:

Teacher's activity: Teacher will instruct the pupils to heat the substances and smell the odour of the substances under heating.

Pupils' activity: Pupils will heat a little of the substances taking one at a time. They will smell the odour of the substances under heating and note down the odour.

Specific processes to be learnt: DU.1, DU.2, DU.5, DU.9.

STEP.3:

Teacher's activity: Teacher will instruct the pupils to categorise the data recorded in another sheet of paper.

Pupils' activity: Pupils will categorise the data recorded in another sheet of paper marked as $'T'_2$.

Specific processes to be learnt: DU.6, DU.8.

STEP.4:

Teacher's activity: Teacher will instruct the pupils to analyse the data in $'T_2'$ and draw inferences.

Pupils' activity: Pupils will analyse the data and draw the inferences, such as - if odour is coming out on heating a substance then the substance is organic, and if no odour is coming out then the substance under examination is inorganic. They will then classify the materials collected into two groups, Organic and Inorganic and record it in the paper marked $'T_2'$.

Specific processes to be learnt: PO.2, PO.6.

PHASE-II (Only organic substances)

STEP.1:

Teacher's activity: Teacher will instruct the pupils to heat one of the organic substances in the metalic cap, collected and observe the odour and flame of the substamces when strongly heated.

Pupils' activity: Pupils will heat one of the Organic substances in the metallic cap of a bottle and observe the odour and flame of the substances under heating and note down. They will repeat the procedure with each of the organic substances.

Specific processes to be learnt: DU.2, DU.5,DJ.9

STEP.2:

Teacher's activity: Teacher will instruct the pupils to categorise the substances separately using the recorded data.

Pupils' activity: Pupils will categorise the organic substances according to the type of flame produced by the substances under heating. Those substances which formed sooty flame will be put in one group and the substances formed non-sooty flame will be put in another group.

Specific processes to be learnt:- DU.2, DU.5,DU.9.

STEP.3:

Teacher's activity: Teacher will instruct the pupils to analyse the data, recorded, and draw inferences.

Pupils' activity: Pupils will analyse and draw inferences, as follows. The substances which formed sooty flame under heating, are Aromatic organic substances and the substances, which formed non-sooty flame under heating, are Aliphatic organic substances.

Specific processes to be learnt: PO.2, PO.6.

PHASE - III ( Only Aliphatic substances )

STEP.1:

Teacher's activity: Teacher will instruct the pupils to add Potasium Iodide solution in Aliphatic substances and to observe and note down the effect.

Pupils' activity: Pupils will add Potassium Iodide solution drop by drop in Aliphatic substances. ( oil mainly ). By adding one or two drop of Potasium Iodide solution into coconut oil, it will become coloured and by adding the Potasium Iodide solution in to mustard oil no coloration will be formed, immediately.

Specific processes to be learnt: DU.2,DU.4,DU.5.

STEP.2:

Teacher's activity: Teacher will instruct the pupils to categorise the data, recorded .

Pupils' activity: Pupils will categorise the data recorded.

Specific processes to be learnt: DU.6, DU.8.

STEP.3:

Teacher's activity: Teacher will instruct the pupils to analyse the data and to draw inferences.

Pupils' activity: Pupils will analyse the data recorded and give their conclusions as per the following.

By adding Potasium iodide if the colour of the substance changes immediately, then the substance is saturated and if the colour does not changes immediately by adding one, two drops Potasium Iodide then the substances are unsaturated.

Specific processes to be learnt: PO.2, PO.6.

## PHASE - IV ( Only inorganic substances )

### STEP.1:

Teacher's activity: Teacher will instruct the pupils to add lemon juice, lime water, separately, to each of the inorganic substances and to observe the changes of colour and formation of precipitates and to record them in each case.

Pupils' activity: Pupils will do as per the above instruction of the teacher.

Specific processes to be learnt: DU.3, DU.4, DU.5.

### STEP.2:

Teacher's activity: Teacher will instruct the pupils to categorise changes occured by adding lemon juice, lime water and also note down the cases where no changes occured by the addition of either lemon juice or lime water.

Pupils' activity: Pupils will categorise the data recorded. They will put the substances acted on by lemon juice in one group, acted upon by lime water in a second group and substances showing no reaction in the third group.

Specific processes to be learnt: DU.6, DU.8.

### STEP.3:

Teacher's activity: Teacher will instruct the pupils to analyse the data and to draw inferences.

Pupils' activity: Pupils will analyse the data and draw the inference as per the following.

1) Substances reacted upon by lemon juice are acidic.
2) Substances reacted upon by lime water are alkaline.
3) Substances showing no reaction are placed as neutrals.

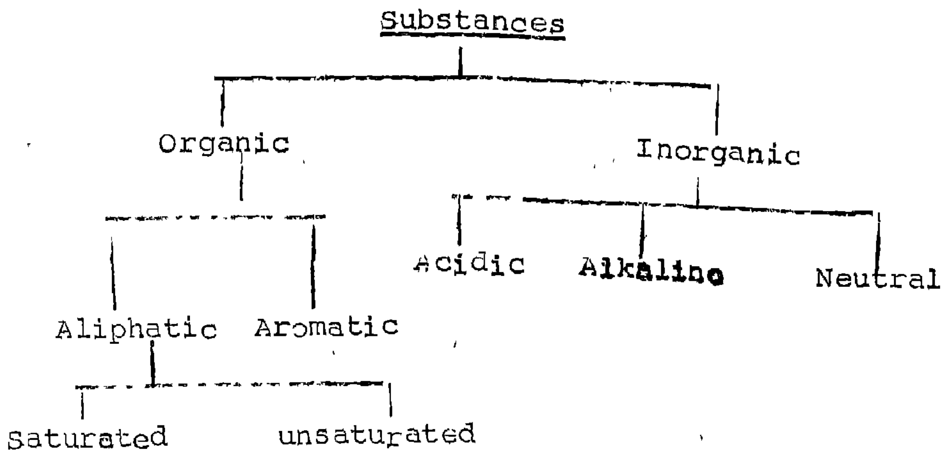
Specific processes to be learnt: DU.2, DU.6.

## PHASE - V (Final classification)

### STEP.1:

Teacher's activity: Teacher will instruct the pupils to analyse the data recorded from Phase-I to Phase-IV and make a classification of the substances, available in the kitchen.

Pupils' activity: Pupils will analyse the data recorded from Phase-I to Phase-IV and make a classification as follows:



Specific processes to be learnt: PO.2.

## Process-based Practical No.14

| | |
|---|---|
| DISCIPLINE | : Physical Science(Chemistry) |
| LEVEL | : Class - IX |
| TITLE OF ACTIVITY | : Investigation about solubility of different solutes in water at different temperature. |
| Name of the participants who prepared the draft. | : Mr.Umesh Chandra Bhukta |

Title of activity: Solubility of different solutes in water at different temperatures.

Approximate time required : 50 minutes

Type of activity : Group activity to be conducted in school.

List of possible processes to be learnt. :
PR.1, PR.2, PR.4, PR.6.
DU.1, DU.2, DU.3, DU.4, DU.5,
DU.8, DU.9.
PO.1, PO.3, PO.6, PO.7.

Pre-requisite knowledge. :

1. Water dissolves a few common substances e.g. Sugar, Salt, Fertilizers, etc.
2. Solutions can become saturated.
3. Ability to prepare a saturated solution.

Materials required:

(a) Available:

(i) Common Salt, (ii) Sugar, (iii) Fertilizer (Urea), (iv) Water containers (Glass), (v) Stove, (vi) A small bottle with cap, (vii) Common weighing balance.

(b) To be improvised: Nil

(c) To be purchased:

Thermometer ( Celecius)

Procedure

STEP.1:

Teacher's activity: Teacher asks the pupils to collect materials mentioned above and he himself collects a thermometer.

Pupils' activity: Pupils will collect the materials.

Specific processes to be learnt:- PR.2.

STEP.2:

Teacher's activity: Teacher asks the pupils to wash and dry the glasses, level with names the bottles containing Sugar, Salt and Urea.

Pupils' activity: Pupils will clean the materials.

Specific processes to be learnt: PR.4, PR.6.

STEP.3:

Teacher's activity: The teacher sets up the experiment. Asks three of the students to come up and assigns each with Salt, Sugar and Urea, respectively, and tells them that they are to prepare saturated solutions of these solutes.

Pupils' activity: Pupils take charge of the bottles containing Salt, Sugar and Urea.

Specific processes to be learnt: PR.1, PR.4,PR.6.

STEP.4:

Teacher's activity: Asks the pupils to take same volume of water in each glass. Taking the cap of the bottle as a standard for measuring solutes, asks the pupils to add one cap-ful of solute to water and stir. When the solute has completely gone into solution he advises them to go on adding one cap-ful more and repeat the process. He asks them to keep an account of the number of caps of solute added to water.

Pupils' Activity: The pupils follow the instructions of the teacher and take note of the amount of solutes, interms of Caps, added to the water.

Specific processes to be learnt: DU.1, DU.5.

STEP.5:

Teacher's activity: The teacher directs the pupils to go on adding capfuls of solutes in the solution till the solution reaches a saturated state.

Pupils' activity: The pupils prepare saturated solutions and find out that no more solutes go into solution if added.

Specific processes to be learnt: DU.1, DU.3, DU.4.

STEP.6:

Teacher's activity: The teacher directs the pupils to note down the amount of water taken and the temperature of the room using the thermometer . . and the number of caps of solutes water has dissolved until the point of saturation is reached. He directs them to tabulate their observations as follows:

Table - 1

| Name of substance | Temp. room | No. of caps of solutes | Amount of solutes in gms. |
|---|---|---|---|
| Sugar | | | |
| Salt | | | |
| Urea | | | |

Pupils' activity: The pupils fill-up the table with the data.

Specific processes to be learnt: DU.4, DU.5

STEP.7:

Teacher's activity: The teacher directs the pupils to find out the weight of a capful of sugar, salt and urea one after another and convert the caps into gms. and to write against each substance in the table in STEP.6.

Pupils' activity: Follow the directions of the teacher, weigh and do the conversion of caps into gms.

Specific processes to be learnt: DU.1,DU.3,DU.5.

STEP.8:

Teacher's activity: The teacher asks the pupils to calculate the amount of solute in grams per the bottle of water. Asks to generalise the concept of solubility.

Pupils' activity: Pupils generalise the concept.

Specific Processes to be learnt: PO.1, PO.3, PO.7

STEP.9:

Teacher's activity: The teacher asks the pupils to ignite the stove and heat a solution to 50°C. The increase in temperature be recorded with a thermometer and asks to observe and stir the solution while heating.

Pupils' activity: The pupil follows the instructions for a particular solution.

Specific process to be learnt: DU.1, DU.4, DU.8.

STEP.10:

Teacher's activity: The teacher directs the pupils to prepare again a saturated solution at 50°C and to keep note of the amount of salt in caps to be put-into. He cautions that the thermometer is to be used to note that the solution stays at 50°C.

**Pupils' activity:** The pupils do as per the instructions of the teacher.

**Specific processes to be learnt:** DU.1, DU.4, DU.9.

### STEP.11:

**Teacher's activity:** The teacher directs the pupils to raise the temperature of the solution to 60°C and prepare again the saturated solution and observe precautions.

**Pupils' activity:** Pupils will follow the instructions.

**Specific processes to be learnt:** DU.1,DU.4,DU.9.

### STEP.12:

**Teacher's activity:** The teacher asks the other students to repeat the experiment with the other two solutions.

**Pupils' activity:** The pupils will follow the instructions.

**Specific processes to be learnt:** DU.1,DU.2,DU.4,
DU.9.

### STEP.13:

**Teacher's activity:** The teacher gives them the table specified below and asks them to note down the data obtained in the tabular form.

Table - 2

| Solute | Temperature | No. of caps of solute to prepare saturated solution. | No. of gms. of solute in the saturated solution. |
|---|---|---|---|
| Salt | Room temp. | | |
| | 50° | | |
| | 60° | | |
| Sugar | Room temp. | | |
| | 50° | | |
| | 60° | | |
| Urea | Room temp. | | |
| | 50° | | |
| | 60° | | |

Pupils' activity: Pupils will note down the data in the table shown above.

Specific processes to be learnt:- DU.5.

STEP.14:

Teacher's activity: Teacher asks to make inferences from the data.

Pupils' activity: Pupils will infer that solubility of water varies at different temperature and increases with the rise in temperature of the solution.

Specific processes to be learnt: PO.6, PO.7.

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# REPORT OF THE PROGRAMME DIRECTOR

Keeping in view the continuous effort of the N.C.E.R.T. for the qualitative improvement of school education in general, and science education in schools, in particular, this Workshop on 'Development of process-based practicals in physical science at the secondary level' was planned and designed. This is the second one of its type. The first one was conducted during February - March, 1993 at Shillong where the participants were from Assam, Meghalaya and Sikkim. This workshop, held from 23.7.93 to 29.7.93, at the Regional College of Education, Bhubaneswar was planned for participants from West Bengal and Orissa, Even after continued efforts in the form of letter, reminder, telegram and request over telephone no names of participants sponsored by the West Bengal authorities was received. The letters of invitation were sent to 14 participants of Orissa and only 8 of them reported for the workshop.

The workshop was inaugurated by Prof.S.T.V.G. Acharyulu, Dean of Instructions, Regional College of Education, Bhubaneswar. In his address he detailed out how a sea of change has appeared in the design of curriculum and text-book after the epoch making event of placing the Sputnik - I in orbit. In U.S.A. this was followed by the conceptualist - impericist approach by Schwab and the discovery learning approach by Suchman. The PSSC books appeared in U.S.A. More stress was given to discovery by the child than on rote learning of whatever is delivered by the teacher inside the classroom.

There were two extended sessions in which the participants were exposed to the identification and design of process-based practicals in physical science. A total of 9 problems, 5 from Physics and 4 from Chemistry, were placed before the participants for designing suitable process-based practicals. The problems were selected to help the participants know about practicals having either a holistic approach, or, a discovery approach, or, definite use of interpolation and extrapolation, or, inbuilt technique to arrive at conclusions through the process of elimination etc.

There after the participants were divided into 4 groups and each group was asked to identify the processes involved in the practicals of physical science. The list of processes as presented by each group was discussed in detail in an open house and finally a list of 30 processes was prepared for use and reference. These 30 processes were classified into three groups, namely Pre-experiment (PR), During - experiment (DU) and Post-experiment (PO).

The groups then sat down and tried to identify as many problems as possible in the frame-work of secondary levelcurriculum. A total of 30 such problems were presented by the groups and their suitability to design process-based practicals was discussed. A total of 14 problem were finally selected.

The groups were then engaged in designing the format in which the instruction materials will be written so that the teacher can meaningfully comprehend them. Without external help and try to implement them in a classroom situation. The final format was decided only after group and open-house discussion. The participants then wrote down the self instructional material, highlighting the processes to be learned in each step of the activity. The drafts were discussed and finalised.

The valedictory function was chaired by Prof.K.C.Panda, Principal, R.C.E., Bhubaneswar. He discussed how practicals are essential tools to improve the degree of meaningful learning. He emphasized the need for propagating this message of designing practicals at a no-cost basis and helping pupils and teachers learn the scientific processes involved in doing these practicals.

The participants eloquently admitted that in their long service career this is the first time they have been exposed to such a novel and fruitful idea and have been put to such rigorous training. In their opinion,

a) more workshops in this area are needed,

b) such practicals should be designed for use from primary level to the higher secondary level, and

c) the state government may be requested to propagate the message through a multiplier scheme.

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## DEVELOPMENT OF PROCESS-BASED PRACTICALS IN PHYSICAL SCIENCE AT SECONDARY LEVEL.

From 23.7.93 to 29.7.93

1. Sri Umesh Chandra Bhukta,
   Asst. Teacher,
   Govt. Secondary Training School,
   Umerkote, Dist:-Koraput.

2. Sri Gopal Krishna Bebortha,
   Asst. Teacher,
   Govt. Secondary Training School,
   Nowrangpur.

3. Sri Purna Chandra Rout,
   Asst. Teacher,
   Govt. Secondary Training School,
   Kendrapara, Cuttack.

4. Sri Ramani Ranjan Rout,
   Asst. Teacher,
   Govt. Secondary Training School,
   Pahimahura,
   At:-Pahimahura, P.O. Barikpur Bazar,
   Dist:- Bhadrak.

5. Sri Nihar Ranjan Mohanty,
   Headmaster,
   Govt. Secondary Training School,
   Rajsunakhala, Dt. Puri.

6. Smt. Preetilata Jena,
   Lecturer,
   Radhanath Institute of Advanced
   Studies in Education, Cuttack.

7. Sri Abhimanyu Das,
   Govt. Secondary Training School,
   Polasara, Dist:-Ganjam.

8. Sri Prasanta Kumar Mohapatra,
   Headmaster,
   Govt. Secondary Training School
   Chikiti, Dt. Ganjam.

## LIST OF INTERNAL RESOURCE PERSONS.

1. Dr. J.K. Mohapatra,
   Reader in Physics,
   & Prog. Director.
2. Dr. H.H. Tripathy,
   Reader in Chemistry.
3. Dr. V.G. Jadhao,
   Reader in Physics.
4. Dr. (Mrs) N.T. Chhotaray,
   Sr. Lecturer in Chemistry.
5. Dr. B.K. Parida,
   Sr. Lecturer in Physics.
6. Mrs. M. Mohapatra,
   Lecturer in Physics.

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